Balancing the Juggling Act
Getting the right attitude
By Thomas A. Horne

Piloting an airplane has been likened to a kind of elaborate juggling act. To do it safely, you have to do many things at once — keep an eye out for other traffic, keep track of groundspeed and fuel consumption, monitor the instrument panel, and watch out for signs of adverse weather, to name but a few important tasks. This ability to effectively divide your attention is one of the major benefits of learning to fly. Flying solely by reference to instruments calls for an even higher level of these skills. Whether you're practicing under a hood or another view-limiting device or actually flying in cloud or poor visibility, your world shrinks to the panel in front of you. There's no horizon to give you direct or indirect evidence of a change in your airplane's pitch or bank. Flying along in this claustrophobic cocoon, the juggling act heats up. You must control your attitude and airspeed to tight tolerances, navigate precisely, and follow the clearances given to you by air traffic control. You have to communicate with ATC, as well, and be thoroughly familiar with the special procedures and quirks, not just of your airplane, but of the airspace you're flying in — and the terrain you're flying above.

Pitch, bank, power
But first things first. The prime directive, way ahead of navigation and communication in priority, is to fly the airplane. To do this properly while flying on instruments requires that you develop — and keep current — your basic attitude flying skills. You have to learn how to interpret and trust what the basic six flight instruments are saying, understand how to act on that information, and know the workings of those vital gauges. Their operational categories break down into three informational groups: pitch, bank, and power. Learn how to manage pitch, bank, and power and you've learned the heart and soul of instrument flying. For pitch information there are the airspeed indicator, the attitude indicator, the altimeter, and the vertical speed indicator (VSI — once popularly called the rate-of-climb indicator, but it also gives descent rate information). For bank information you have the attitude indicator, a heading indicator, a turn coordinator (or turn-and-bank indicator), and a magnetic compass. For power information, there are the tachometer, manifold pressure gauge (if so equipped), fuel flow gauge (if so equipped), and airspeed indicator. If you're flying turbocharged or turbine-powered aircraft, still other power-related gauges will be on the panel.

Triangles of agreement
Armed with this information, how do you put it all together so that you can make the airplane do what you want? More important, how do you know when your instruments are lying? The answer is to cross-compare information sources. If your airspeed is increasing, a check of the attitude indicator, altimeter, and VSI may confirm that you are indeed in a descent. Is there a question about your bank angle? The attitude indicator, turn coordinator, heading indicator, and magnetic compass can help to resolve it — although many would say that the magnetic compass is all but useless in anything other than turbulence-free conditions. [AND there are the few who strongly disagree with the many! jjz]

Has the airspeed dropped off? Perhaps the tachometer will show a reduction in power — maybe because the throttle friction lock has inadvertently backed off, or maybe because
you've picked up some carburetor ice. The point is that there are multiple — usually three — additional sources of information about pitch, bank, and power, over and above the gauge you've been fixating on. Call them triangles. Cross-checking them will usually resolve your situational awareness with regard to attitude, airspeed, and power. If any of the triangles contain elements that don't agree, then you have a problem. Let's say your attitude indicator shows you in a descending left turn, but your other pitch instruments (altimeter, VSI, airspeed indicator) give evidence that you're in level cruise. Let's also say that your heading indicator is showing a turn to the right at the same time, but your turn coordinator and magnetic compass are showing you wings level. You must rule out the attitude indicator and heading indicator. Their information has been outvoted by the rest. It's very possible that your vacuum or pressure pump has failed, leaving you without gyro power to those very critical instruments. In this case, a check of the vacuum or pressure gauge will show a too-low reading.

**Scanning**
The ability to extract and act on instrument information requires an efficient scan technique. Several methods are taught, but all agree that the scan should begin and end with the attitude indicator. From there, the eyes go to the heading indicator, dart over to the altimeter, then to the turn coordinator, VSI, and tachometer/manifold pressure gauge. The vacuum/pressure gauge should also be included as part of the normal instrument scan. This may sound easy, but it takes many hours of concentrated practice to get the hang of flying on instruments. With time and a good instructor, however, your scan's efficiency improves, and your control inputs to correct any pitch, bank, or power excursions become quite smooth — almost second nature. Control inputs should never be abrupt or large when flying on the gauges. Left neglected, however, scanning skills pick up rust rather than speed. The most common problem is fixating on one instrument. Recurrent training and regular practice — under the hood, with a computer flight training device, or in actual instrument conditions (with an instructor at your side) — will keep your scan speedy and your control inputs correspondingly smooth.

**Configuration control**
Knowing what your instruments are telling you is one part of basic attitude flying. Knowing how to make the instruments read the way you want them is another. Here, the trick is to make a chart for the airplane you fly, showing the instrument readings for each of the basic configurations: climb, level flight, cruise descent, descent on a precision approach profile (for use with landings when using an instrument landing system), and descent on a nonprecision approach profile (for landings out of localizer, VOR, GPS, NDB, or other nonprecision approach procedures). A simple chart showing the above should list the following variables across its top margin: manifold pressure (if your airplane is so equipped), rpm, pitch, airspeed, and VSI. Down the left margin, write in: climb, cruise, cruise descent, precision approach descent, and nonprecision approach descent. Now fill in the blanks with the information you glean from a few practice flights on the gauges. Charts with information like this can be made for any airplane. Consult it prior to a configuration change and you'll immediately know the pitch and power settings you want for whatever phase of flight you're about to face. Just make the gauges read what you want.

**Partial panel**
We talked earlier about a failure of the vacuum- and gyro-powered instruments — the attitude and heading indicators. This is a dangerous failure because it can come on slowly, because we tend to rely too heavily on the gyro instruments (especially the attitude indicator), and because it's very easy to become disoriented if your scan's weak and you fixate on an attitude indicator that's rolling over dead. To combat the dangers of vacuum pump failure, remember the triangles of agreement — and check the vacuum gauge. If the pitot-static and electrically powered instruments (e.g., the turn coordinator or turn-and-bank indicator) outvote the vacuum instruments, you know to ignore the latter. The best way to ignore the failed instruments is to cover them up. Use tried-and-true suction cup-type soap holders, Post-it self-stick notes, a folded dollar bill wedged into the space around the instrument face, or anything else that will stick to and cover up the offending instruments. Now the real work begins. You have to use pitot-static instruments for pitch and the turn coordinator and magnetic compass for bank information. Partial panel flying requires a very rapid scan and a very light touch on the controls. Whatever you do, ignore the gyro instruments. It will be of utmost importance that you learn the ins and outs of the magnetic compass, a quirky holdover from the earliest days of flying. When you are turning through northerly headings, this instrument's indications lag behind your real heading. When you are turning through southerly points of the compass, the magnetic compass' indications will shoot past your actual heading. In turns to easterly and westerly headings, the compass will be fairly accurate. In turbulence the magnetic compass headings will be all over the place. With practice you can turn to magnetic compass headings and come pretty close to nailing them. The tendency is to let partial panel flying skills slide. Maybe that's why instrument pilots taking instrument proficiency checks are required to demonstrate their ability to safely fly on partial panel.

**The good news**
The good news is that learning to fly solely by reference to instruments makes you a more competent pilot in all phases of flight. You don't have to launch into a low ceiling to realize that your overall flying skills benefit from instrument competence. You'll find that you can hold altitude and heading much better, and your control of the airplane is more precise. This holds true, however, only if you stay current — whether you're instrument-rated or not.

**Lexicon**
*Vertigo:* A catchall term for the confusing sensations caused by movements of fluids in the inner ear. You may feel as if you're in a turn ("the leans"), or tumbling, or climbing, or descending — when you're not. To help prevent vertigo, keep head movements to a minimum and trust your instruments.

*Vacuum/pressure system:* A system comprising a pump or pumps that generate vacuum or pressure, air filters, vacuum or pressure regulators, a suction or pressure gauge, and lines connected to the air-driven gyro instruments. Pumps are attached to the engine's accessory case and driven by accessory gears. Dry pumps are the most common; these use rotating carbon vanes to generate vacuum or pressure. When the vanes get old, they chip and parts of them break off, causing the pump to seize.

*No-gyro approach:* A type of nonprecision approach meant for use with inoperative gyro instruments. By viewing radar returns off your aircraft, ATC issues "turn" and "stop turn" commands to help you line up with a runway for a descent on instruments. It's a great
help when trying to navigate by magnetic compass alone. In effect, ATC commands take
the place of the magnetic compass. All turns are made standard rate until you are on final
approach. Then turns are made at half-standard rate.

**Level-off leadpoint:** The altitude at which you should begin applying control pressures
for level flight. This altitude is calculated by using 10 percent of the climb or descent
rate. If you're climbing or descending at 500 fpm, then begin leveling off 50 feet before
reaching the target altitude.

**Nose-high unusual attitude:** A condition where the airplane is undesirably nose-high. To
correct, apply power as needed, lower the nose, then roll wings level.

**Nose-low unusual attitude:** A condition where the airplane is undesirably nose-low. To
correct, reduce power, roll wings level, then slowly raise the nose.

**Tip Sheet**

- When banking, use no more than a standard bank angle. This is three degrees per
  second, or 180 degrees in one minute. Standard-rate bank markers can be found
  on the turn coordinator or turn-and-bank indicator. Standard-rate banks help to
  prevent over controlling, vertigo, and unusual attitudes.
- When making small heading corrections with the magnetic compass — as when
  tracking a VOR radial or localizer — use timed turns and keep the timing limits
  low. Count "two chimpanzees" (or use a clock/timer) for a six-degree heading
  change; count three seconds for a nine-degree change, etc.
- Don't chase instrument indications. This can also cause over controlling and
  unusual attitudes. Instead, make a modest control input, then wait for a few
  seconds to see how the instruments respond.
- Turn on the pitot heat well before flying in cloud or visible precipitation no matter
  what the temperature.
- Is there a dedicated alternate source of static air for your airplane's pitot-static
  instruments (the airspeed indicator, altimeter, and VSI)? If so, open it if you
  suspect that the static ports may ice up. Without a dedicated source of alternate
  air, you'll have to break the face of the VSI to let alternate static air into the
  system, rendering the VSI inoperative.
- Don't stare at any single instrument! Keep your scan moving and try not to slow
  down.
- The primary instrument for pitch information in level flight is the altimeter. In a
  climb or descent, it's the airspeed indicator and VSI.
- The primary instrument for bank is the heading indicator.
- Vacuum and pressure pumps typically fail after 400 hours' time in service.
  Replace them before they quit in the air.
- Pulling your propeller through backward can chip the carbon vanes in your
  vacuum pump.